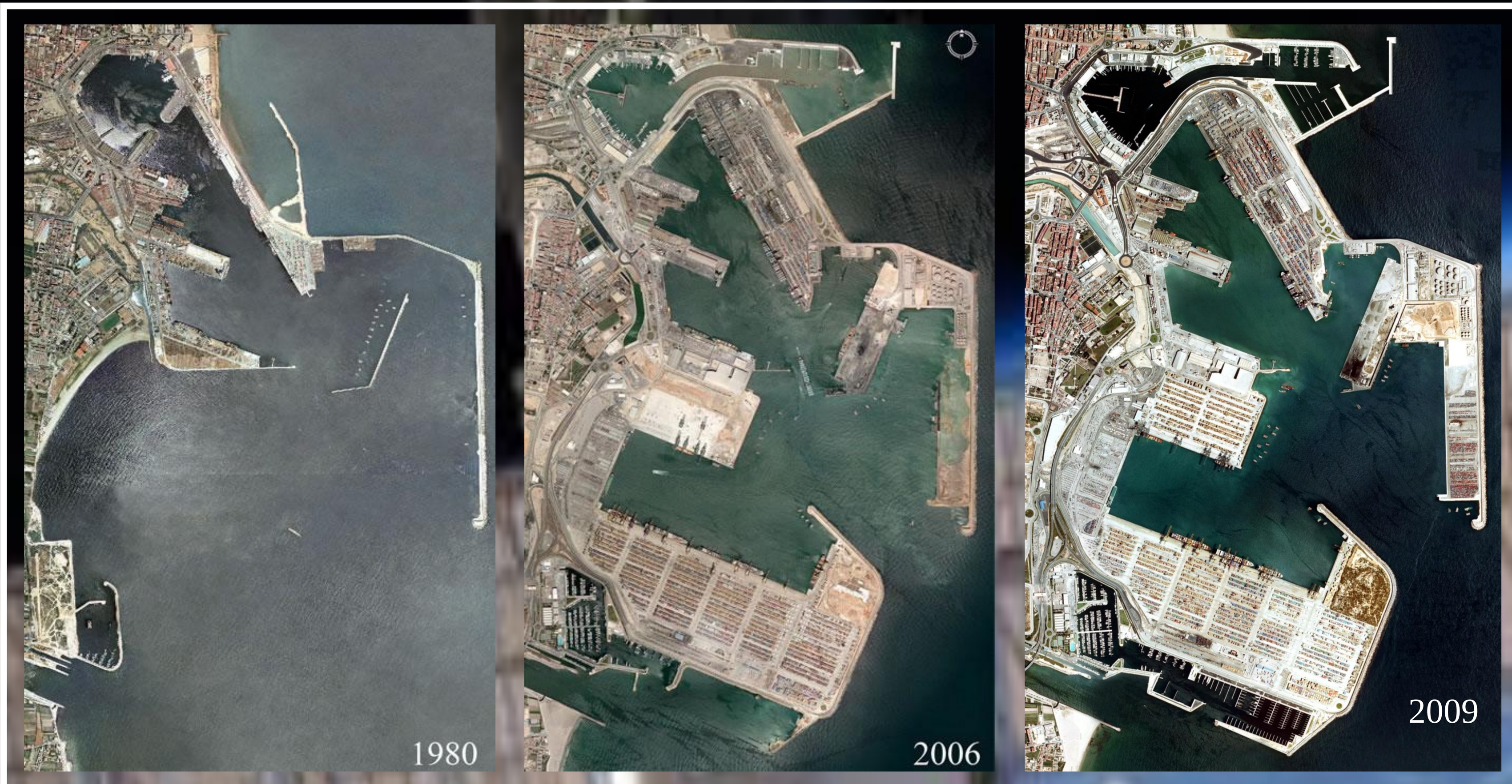
SUBSIDENCE DETERMINATION IN THE CITY OF VALENCIA AND ITS SOURRONDINGS USING RADAR INTERFEROMETRY

J. Manuel Delgado, Fabio Cian, Ana B. Ruescas, Francesco Sarti, Mihai Datcu and Raquel Capilla

Construction works in the city of Valencia are changing continuously the appearance of the city: new metro lines, the construction of the high speed track lanes for the train between Madrid and Valencia, the renewal of the districts of El Grao, Cabanyal and Campanar, and some other works for the extension of harbor area including the facilities for the America´s Cup and the Formula 1 circuit. The city of Valencia is located over a quaternary alluvial plane with a complex hydro-geological system. Due to its proximity to the sea, the phreatic surface is at only seven meters depth, and constructions works are always affected by this fact and the special characteristics of a unstable but very fertile soil.



Evolution of the port area of Valencia from 1980 to 2009

Objective

The objective of this work is the detection and mapping of ground subsidence related to human activities using differential interferometry techniques (DInSAR) over a period of seven years (2003-present) using a small perpendicular baseline (< 500 m) interferogram approach. In this poster, the attention is put on the harbour area, the part of the city that has suffered more changes in the last 25 years.

Data

Seven year ENVISAT archive of 21 Advanced Synthetic Aperture Radar ascending (8) and descending (13) images from 2003 to present. Total number of valid interferograms: 4 ascending and 5 descending.

Eight months TERRASAR-X strip-map images from October 2009 to may 2010: 8 images descending. Seven valid interferograms in total.

GPS measurements on the harbour area for a future validation process.

Procedures

We use the Delft Object-oriented Radar Interferometric Software (DORIS) of the Delft Institute of Earth Observation and Space Systems to build the differential interferograms and unwrap them. Orbital fringes are removed using precise orbits provided by the European Space Agency and the Delft University of Technology.

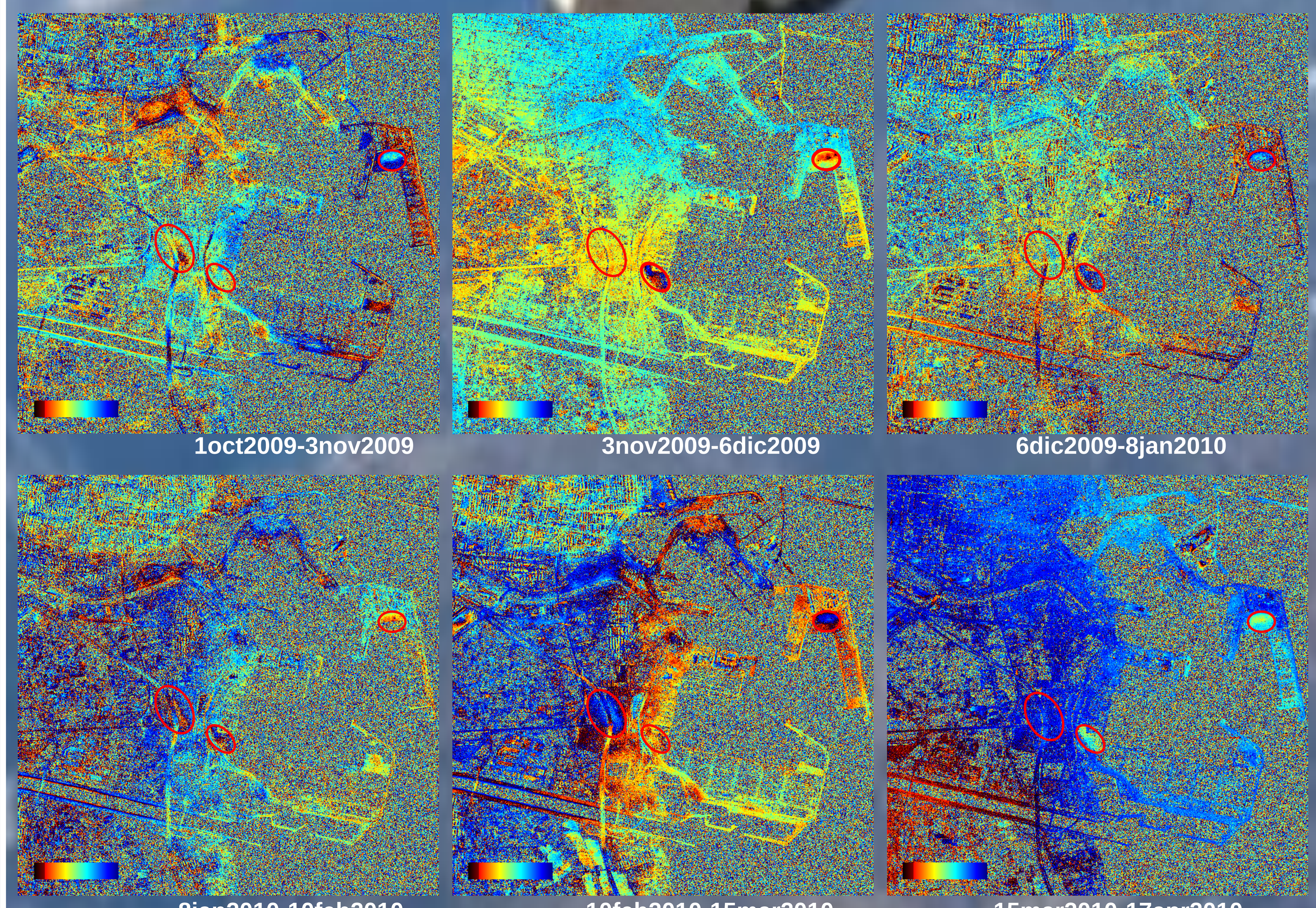
The topographic contribution is removed using the a 30 m spatial resolution digital elevation model (DEM) provided by the Advance Spaceborne Thermal Emission and Reflection radiometer (ASTER) by the Jet Propulsion laboratory (JPL).

Multilooking of a factor of 5 is applied to the ASAR interferograms along the azimuth (100 m x 100 m final pixel resolution), and of a factor of 2 to the TerraSAR-X interferogram along the azimuth and range (8m x 8m final pixel resolution) .

The unwrapping process is made using the Statistical-Cost, Network-Flow Algorithm for Phase Unwrapping (SNAPHU) by Chen & Zebker (2002).

We analyzed mainly three areas in the vicinity of the port, which show an interesting behaviour. The measured displacement, extracted from the relationship with the unwrapped interferogram, ($d=\Phi\lambda/-4\pi$), has been referred to an area of the old part of the port.

Interferogram results with all the pairs with 33 days of temporal baseline.



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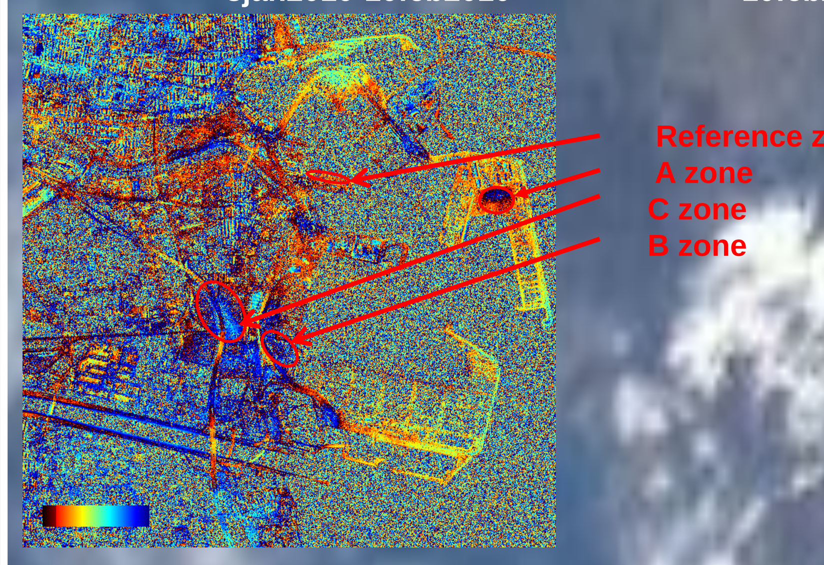

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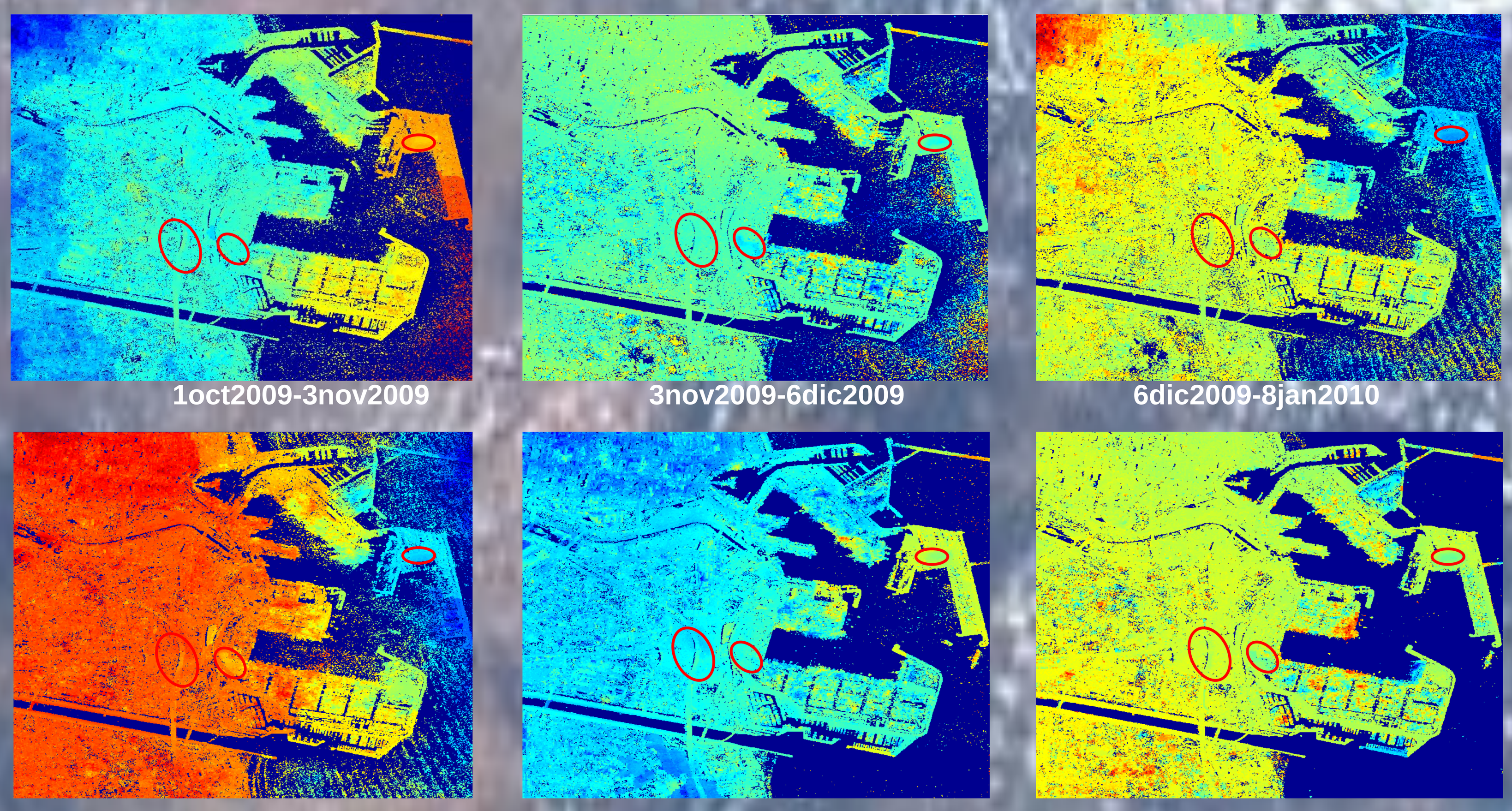
There are three areas that show terrain motion in the harbour area:

Zone A: shows movements of subsidence and uplift, probably due to the use of this area as a loading dock of material used for the expansion of the harbour to the North. The subsidence could be caused by the packing of material that has been there for a long time, caused by humidity or water infiltration.

Subsidence



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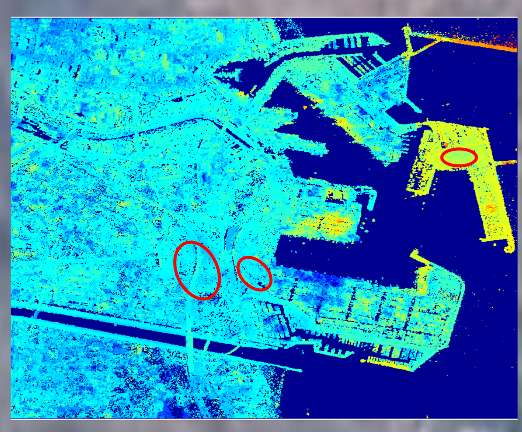

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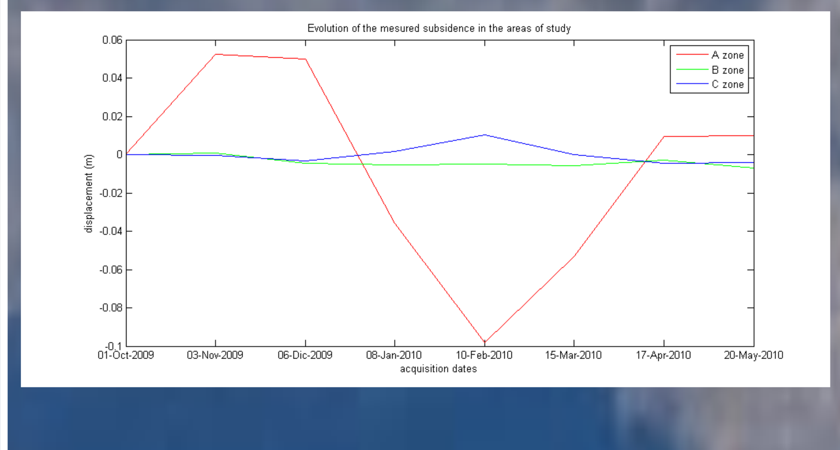
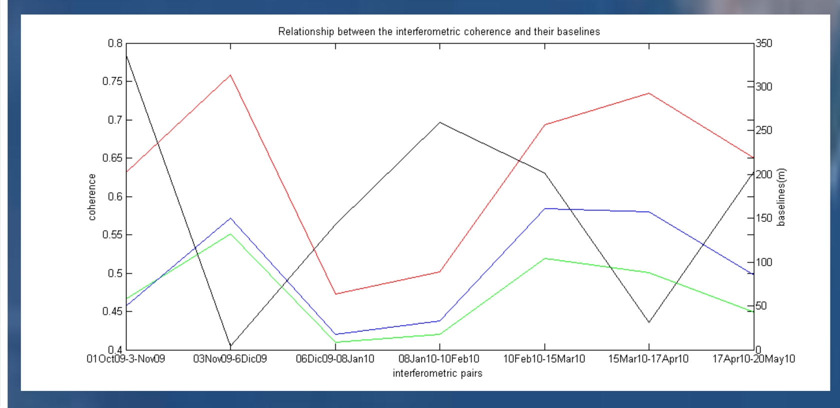
Zone B: shows clear and very localized displacement in more than one interferogram. The area covers a zone of the port where cars for the import/export market are stored. More research should be done to determine why subsidence is only observed in this part and not in others storing containers or other goods as well.

Zone C: this is crossed by one of the main roads that exits the city in the South. It is an area with intense traffic and very near the channel of the Turia River. The entrance of sea water or river swollen that packs the dirt and provokes a rise in the phreatic levels could be the caused of the subsidence here.

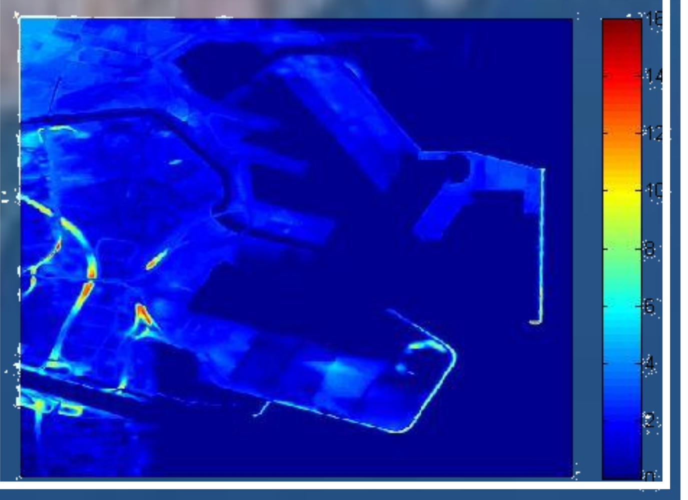
Discussion

The qualitative results showed are reliable, but still more precise quantitative analysis is needed. The atmospheric correction of the images have to be improved as well as the use of a more accurate DEM in the interferogram extraction process. New acquisitions and hopefully the use of very high resolution TSX Spotlight images could help in the understanding of some subsidence cases. Furthermore GPS data, provided by the *Autoridad Portuaria de Valencia*, that are now being processed at the *Institut Cartogràfic Valencià* (ICV) will provide a proper quantitative validation of the work.





DEM 10m spatial resolution provided by IGN



Future Lines

The research will continue making use of the Stanford Method for Persistent Scatterers. A more accurate DEM provided by the *Instituto Geografico Nacional* (IGN) will be used for the topographic correction (10 m spatial resolution). The temporal baseline of the study need also to be extended, integrating previous dates using ASAR and new acquisition of Spotlight Terrasar-X. The extension of the study area to the whole city could provide very useful information about the areas affected by terrain movements due to natural or artificial causes in order to establish the necessary protocols.

Acknowledgements

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